KICKER

What is the difference between continuous RMS vs. peak power? (…and why does it matter?)

Power definition:

Power is the rate, per unit time, at which *energy* is transferred. The standard accepted unit of power is the Watt. Power can be expressed in several ways. This discussion will explore the differences between RMS power, Dynamic power, and Peak or "MAX" power.

RMS Power:

When measuring a pure sine wave, RMS voltage can be calculated by measuring the peak voltage level and multiplying it by 0.707. This value can then be used to calculate RMS power. In turn, if the RMS power is known, it can be used to calculate the peak power. This is only accurate for a pure and unclipped sine wave. Continuous power output is the amount of power that that an amplifier can produce for a prolonged period of time. There is an organization called CTA (Consumer Technology Association, formerly known as the "CEA".) that has developed a test standard that is agreed upon by a committee of car audio industry experts. Adhering to the standard is voluntary for manufacturers, but if a product displays the CTA-2006-B logo, you can be sure that the ratings given are accurate. The CTA standard specifies that an RMS power rating is taken at 14.4 Volts, with 4 Ω loads, and less than 1% THD (total harmonic distortion), over the rated bandwidth of the amplifier. The amplifier must meet all of these criteria for at least one minute in duration. In addition, the bandwidth spec is necessary because some amplifiers can produce more power at just 1 kHz versus the full audio bandwidth of 20Hz to 20 kHz. The one-minute time requirement proves that the power supply is able to maintain rated output for a sustained period of time versus a quick burst that cannot be sustained.

Dynamic Power:

Dynamic power is defined by CTA-2006-B to be the amount of power delivered during a short 20-cycle burst at 1kHz or 10 cycles at 50Hz. Very few manufacturers use this rating because it will only give a slightly larger number than continuous RMS power if it is larger at all.

Peak or MAX power:

Real peak power output of car audio amplifiers can be accurately calculated from the continuous RMS ratings, but many manufacturers take a LOT of liberty as to how they "calculate" these numbers. Often called "MAX Power" this rating is often very over-inflated. Some companies will double the rated RMS continuous power output and call it MAX power. Some companies even go higher than double rated RMS power. Some companies will just assign what seems like a random power output value to their amplifier that looks impressive and leave it up to the consumer to believe or not. Many of these power ratings will not give a test battery voltage or distortion output value. One name for these inflated power ratings is "screen on power". The manufacturer just prints (or screens) the MAX power output on the amp and box without any qualification, certification or accuracy… once again: buyer beware.

Real Calculation of Power:

By rearranging the basic power formula we can arrive at 3 different ways to calculate power. It is necessary to know any two of the following: voltage (V), current (I), or resistance (R) in order to calculate power (P). Use the appropriate formula below to calculate power.

$$P = V*I$$

$$P = I^2*R$$

$$P = V^2/R$$

These formulas are only accurate for situations using accurate test equipment and a constant known value for voltage, resistance, and/or current. If the amplifier claims 2000 watts and it has a single 30 amp fuse, it should be obvious it is over-rated. Using these formulas above, it takes 167 Amps at 12 Volts to product that power at 100% efficiency (which is virtually impossible). This would certainly blow the 30 Amp fuse before it got close to that power output. Also note, typically amplifiers are 50 to 90% efficient. The power that does not get delivered to a speaker is dissipated as heat through the heat sink of the amplifier. But how is it possible to calculate power from a car audio amplifier at a specific frequency? Simply use a signal that does not change such as a sine wave for signal. Speakers do not make good loads for amplifier testing due to the fact that they radically change resistance with frequency (impedance). If a speaker has a 4 Ω rating, it does not mean that it is exactly 4 Ω all of the time. The DC resistance may be only 3.4 Ω and due to the impedance curve it may go up to 50 Ω (or higher) depending on the enclosure. The impedance of any speaker will also change with heat, the enclosure volume (and type), and the specific frequency played. Again, the CTA-2006-B test spec calls for non-inductive load resistors 4 Ω that do not vary more than 5% in value during the test. A good rule of thumb is to use resistor loads with a power rating twice as much as the amplifier under test will produce. The standard test frequency is 50 Hz for a sub amp and 1 kHz for a full range amp. The input to the amplifier must remain unclipped. This should be monitored with an Oscilloscope. Measure the RMS voltage at the speaker terminals with an AC Volt meter and/or an Oscilloscope. Then use these measurements and values to calculate the power.

Example:

A sine wave at 50 Hz produced 42 Volts RMS without clipping at the terminals of a 2 Ω lab grade resistor. Use the example below for power calculation.

42 volts^2/ 2 Ω = total RMS power

1764 / 2 = 882 Watts of RMS power at 50 Hz.

Why Does It Matter?:

"MAX" or Peak power numbers don't give any clear indication as to how much power an amplifier actually makes. In turn, this makes it very difficult to properly match up speakers with the right amount of power handling or efficiency to match up with a customer's needs and desires. This misleading "knowledge" also makes it impossible to choose the necessary additions to the vehicle's electrical system including additional batteries, alternator upgrades, wiring, fusing, terminal blocks, etc. and could easily lead to poor performance because these items are under spec or overspending on accessories. In the end, this could easily result in a disappointing customer experience. Using CTA-2006-B standard measurements makes these choices much easier and allows for real comparison between amplifier models.